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ABSTRACT

A review of the relevant literature reveals that reading reversals, whether in sequence or orientation, comprise a very small proportion of the total errors made by even poor readers. Young children tend to make more reversals, yet this tendency generally disappears with age. Top-down theorists feel that the reversal tendency of young children is due to unfamiliarity with the stimuli, and that maturation will alleviate the problem. While bottom-up theorists feel that perceptual training will correct the tendency to reverse, it has been demonstrated that this type of training is generally unsuccessful, particularly with children beyond age seven. Interactive theorists state that if reversals were a perceptual problem, persistent reversers would exhibit the same problem in other activities, a phenomenon not yet documented. The tendency to reverse has been considered an indicator of dyslexia, but studies with dyslexics and normal disabled readers have demonstrated that the two groups do not differ significantly in the number and type of reversal errors made. Assessing reversals has been fraught with methodological flaws, concatenating perceptual ability with verbal ability, motor ability, and memorial processes. While only a few studies have assessed reversals in connected text, such studies have demonstrated that the proportion of reversals is small compared to the other types of errors made, and that connected text can in fact help a child in constraining the type and number of reversals made. (FL)

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RESEARCH ON REVERSALS,
WITH EMPHASIS ON CONNECTED TEXT STUDIES

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It seems appropriate at the onset to discuss what a reversal is. Reversals involve incorrect perception in either orientation or sequence of symbols, letters, or words. Orientation reversals can occur in either a top-bottom or vertical fashion (i.e. u - n) or a left-right or horizontal fashion (i.e. b - d). Sequence reversals occur when a string of symbols, letters, or words are perceived in an incorrect order (i.e. left - felt, clam - calm, may I go - I may go).

Reversals are quite common in young children who have not yet learned what the concepts of left-right or top-bottom mean, and it is generally agreed that the occurrence of such reversals in either reading or writing prior to the age of seven or eight is not cause for alarm. It is when the tendency to reverse persists beyond this point that much conflict arises among researchers as to the cause and optimal remediation for such problems.

Literature in the field of education continues to address the topic of reversals. Researchers have sought to establish relationships between the tendency to reverse and poor reading ability, poor spelling ability, and poor handwriting ability. Still others have sought to confirm the hypothesis that reversal tendencies are related to handedness, eyedness, and crossed or mixed hand-eye dominance. More recently, reversals have been linked to the rather broad term "dyslexia," one which possesses the quality of definition by fiat for most researchers. The topic of dyslexia per se will not be dealt with in this paper, since research in that area is quite wide spread. A few studies will be discussed, however, which did compare dyslexic and normal readers' performance on perceptual and reading tasks.

The purpose of this discourse, then, is two-fold. Firstly, an overview of the literature will be presented, highlighting the conflicting viewpoints of researchers who have studied reversals. Secondly, the methodological processes employed in assessing reversals will be discussed with specific attention to those few studies which have assessed the tendency for reversal errors when reading in connected text.

Literature Overview

The major conflict of viewpoints among researchers in this field represents a difference at a very basic level, that is, what perception entails. Like reading, perception can be viewed from a top-down, bottom-up, or interactive theory.

Top-down theories are those which characterize perception as being a constructive, inferential act. According to such theories, the information which is stored in the head (often referred to as prior knowledge, schema, script, or experiential background), determines how the individual organizes the information in the environment. Based upon what is already in the head, the individual is said to make predictions concerning new information.

In relation to schooling, Werner (1948) stresses that in young children, a general ability is the common rule, yet as the child grows older, abilities have the tendency to become more specific in nature. Werner (1948) states: "In particular, functions such as verbal, number, spatial abilities and general memory, seem to be more closely related to each other in children than in adults." (p.56a) In accordance with the tenet that perception is selective, functions which are most salient to the individual at a given stage are said to be replaced by other functions at another stage. Thus, top-down theorists view perception as a continually evolving process, and one which improves and becomes more specified with age.

According to Piaget, perception is a constructive process during which the child perceives not only what he sees, but also what he knows. During the sensorimotor stage (approximately 0 to 24 months), the organism's perception is based on sensorimotor schemes. In the preoperational stage (approximately 2 to 7 years), perception becomes increasingly more determined by internal representation, memory playing an important role in symbolization. During the concrete operational stage (approximately 7 to 11 years), perception is determined by the ability to organize relations into a functional system. The three main constructs of Piaget's theory, through which the organism interacts with and adapts to the environment are accommodation, assimilation, and equilibrium. It is prior experience which allows this environmental interaction to take place. Moerk (1975) addresses Piaget's concepts of accommodation and assimilation. He states: "Piaget defines assimilation as the tendency of the organism to incorporate environmental givens into his system of established givens." (p.154) Accommodation is described in the following way: "By means of the function of accommodation, mental structures are adjusted to the structures of reality." (p.156) In Piaget's viewpoint, the human organism will continually strive to adequately adapt itself to the environment so that a state of equilibrium exists between the two. Specifically related to perception, Piaget (1964) states:

"A stimulus is a stimulus only to the extent that it is significant, and it becomes significant only to the extent that there is a structure which permits its assimilation, a structure which can integrate this stimulus but which at the same time sets off the response...I would propose that above all, between the stimulus and the response there is the organism, the organism and its structures. The stimulus is really a stimulus only when it is assimilated into a structure and it is this structure which sets off the response. Consequently, it is not an exaggeration to say that the response is there first, or if you wish at the beginning there is the structure." (p.43)

Top-down theorists, then, note that we cannot expect young children to automatically correctly perceive all stimuli in their correct orientation

or sequence if the stimuli are unfamiliar to the child. Therefore, if when first learning the alphabet, a child mistakes b for d or p for g it is not cause for alarm or diagnosis of perceptual deficit. Since the cognitive structures are said to determine the type and degree of perception, educators adhering to top-down theories would be very selective in their choice of instructional materials. Learning must be meaningful for the child, an idea which has many implications in and of itself. When presenting materials, or eliciting concepts optimally derivable from materials, the teacher must always take care to choose only those for which students possess prior knowledge or for which experiential background can conceivably be built in a relatively short period of time. Concepts, and tasks requiring concepts, should be presented in the context in which they would naturally occur. This would preclude, for example, the presentation of letters or words in isolation, a topic which will be given more attention by bottom-up theories. Since individual differences are inherent in the process of perception, and in the cognitive structures of intelligence and memory which guide this process, top-down theorists might well consider individualized instruction to be the optimal educational form. This last point has implications for the types of assessment which are used to determine whether or not reversals are a perceptual problem. As will later be discussed in detail, most tasks used to assess the tendency to reverse involve the perception of single symbols or words in isolation.

In accordance with the top-down theory of perception, a distinction made by Cohn and Strickler (1976) seems quite pertinent. They stress that we do not know how a reversal occurs, we infer it. They presented 409 young children with three-sided squares and directed the subjects to pretend to draw the missing line. All squares (12 per child) were completed correctly. These children, however, did have trouble in naming letters, more particularly,

lower case letters. Cohn and Strickler concluded that this was not due to faulty perception, since the children had performed so well on the first task. They suggested that the problem must be due to the increased similarity of forms of lower case letters. There were no consistent left-right or right-left reversal patterns exhibited. The authors termed the subjects' errors product reversals. They state: "...although the letter or product d, for example, is the reverse of the letter or product b, the process by which the child says one when he looks at the other has nothing to do with perceptual reversal." (p.165) They offer four explanations for the occurrence of such errors: (1) the child does not know the letter names; (2) the child has not firmly associated names and visual forms; (3) the child does not realize that the names of letters change as their spatial orientation changes; or (4) the child has not developed normal perceptual ability into the acute skill needed for letter naming. They caution against teaching children letter names before they are maturationally ready.

In a study conducted by Goyen and Lyle (1971) the effects of incentive and age on visual recognition were assessed. Subjects included 24 retarded readers (12 aged 7½ yr. to 8½ yr., 12 aged 8½ yr. to 9½ yr.) and 24 normal readers (12 aged 7½ yr. to 8½ yr., 12 aged 8½ yr. to 9½ yr.). Subjects were presented with twenty unfamiliar rectangular shapes in tachistoscopic 10 msec. exposures. They were instructed to look at the response card and choose the figure that matched the one just presented. The choices always included one standard, two reversals of the standard, and two slight transfigurations. The retarded readers worked under an incentive condition in which they were given ½ penny for each correct choice, and were told when they were right. They were also told their score after every fifth stimulus — and encouraged to improve. The normal readers served as the control group, receiving no feedback of any kind. In spite of incentive, it was found that

the younger children from both groups had more recognition errors. It was noted that the normal readers were superior to the retarded readers in the 7½ to 8½ age range, but not in the older group. There was no significant difference between the normal and retarded readers in the number of reversals made by either age group. Goyen and Lyle (1971) concluded that correct perception and recognition are developmental or maturational artifacts for both normal and retarded readers.

Cronin (1967) agrees with the notion that correct perception is developmentally and experientially dependent. She set out to explore children's ability to discriminate mirror image reversals both before and after reading instruction had taken place. Subjects were 144 Kindergarteners and 72 first graders. Subjects were presented with stimuli under three methods: dyads, in which two symbols were either identical or mirror images; triads, in which two symbols were alike and one was a mirror image, all being the same distance apart; and triads in which one standard was on the left and a mirror image pair was on the right (match to sample task). It was found that first graders more often spontaneously discriminated the mirror images. Cronin (1967) attributed this result to the fact that these children, through reading instruction, had learned that orientation is a critical dimension in judging same or different. The Kindergarten children, on the other hand, had not yet begun reading instruction, and therefore, orientation was not a critical factor for them. They were still adhering to the notion that identical objects are still identical regardless of position. The older children had become attuned to orientation as a critical dimension through their experience with letter recognition and discrimination, an experience not yet afforded the younger children.

Bottom-up theories are those in which perception is said to be stimulus determined. Such theories of perception have fostered many studies exploring

the nature in which stimuli are perceived. Where top-down theories supported the notion that an organism will either alter itself or the stimuli in order to maintain an equilibrated state, bottom-up theorists see the individual as organizing the stimuli so that perceptual processing may take place. Wertheimer (1958) aptly summarizes his theory of perceptual organization in the following:

"...perceptual organization occurs from above to below; the way in parts are seen, in which subwholes emerge, in which grouping occurs, is not an arbitrary, piecemeal and summation of elements, but is a process in which characteristics of the whole play a major determining role." (pp.134-135)

Inherent in this theory is that when a child reverses, either in orientation or sequence, he/she is actually seeing or perceiving the stimuli in an incorrect manner. Jordan (1977) who is in agreement with this theory, states: "Most dyslexics see certain letters backwards or upside down." (p.5) Again, in reference to dyslexics, Jordan notes that these children often mistake initial letters, particularly lowercase letters, in either an upside down or backwards fashion, and thus mistake many words for ones that are similar. In order to find his/her mistake in word recognition then, the reader must rely on the context of the material. A top-down or interactive theorist might note that this procedure is not undesirable.

Orton (1937), often considered a proponent of this approach, stresses that reversals, whether they be in orientation or sequence, occur with much inconsistency. For example, it is very uncommon for a child to always read b for d or was for saw; usually the occurrence of correct and incorrect pronunciations are of approximately equal proportions. While Orton himself did not believe that perceptual training would help alleviate specific reading disability, his theory of hemispheric dominance gave rise to such practices.

Many have advocated perceptual training for children who are persistent reversers (Stauffer and Stauffer, 1981; Stern and Spwell, 1980; Pick, 1965; and Gibson, 1968).

Gibson (1968) feels that discrimination training should emphasize the differences in distinctive features, and that contrasts should progress sequentially from broader to finer discriminations. The perceiver becomes increasingly more selective in the perceptual process so that ultimately only those distinctive features or patterns which reduce uncertainty are retained. Gibson (1968) stresses that this selective process improves with age and experience. She defines perceptual learning in the following:

"...perceptual learning is the taking out from the total stimulus information, whatever is invariant about the world, whether it be a distinctive feature of a rule. Things are associated, to be sure; they are always associated in the world when they are contiguous with one another spatially or temporally. Noticing the relationship in information-reducing, whereas processing each sensation separately and associating one with the other would be the opposite." (p.142)

She further adds: "...perceptual learning--discovery of distinguishing features and extraction of invariant patterns and relations-- is a requisite for all the three processes of discrimination, recognition and production, and the processes form a kind of cognitive hierarchy." (p.152) She stresses that practice yields improvement in perception.

Pick (1965) stresses that the function of practice or training in visual perception is to enable the child to respond to an increasing number of stimulus variables and to decide which of these stimulus variables are most salient in distinguishing one stimulus from another. Stern and Sowell (1980) proposed that training in directionality would eliminate reversals in older children, however they conducted a study which disproved this claim. Twenty-four children, aged 8 yr. 1 mo. to 9 yr. 2 mo. who exhibited reversal tendencies served as subjects. They were given a 5 question criterion referenced test which utilized letters and letter sequences which are often reversed. Four weeks later, the children were administered the same test. During the interim, 12 of the subjects received an additional 15 minutes per day of directionality training, involving manipulation of stimuli to the left and

right orientation, matching to sample tasks, etc. While the treatment group did reduce the number of reversals made on the posttest, there was no significant difference between their performance and that of the non-treatment group. It was concluded that directionality training is unsuccessful with children beyond the age of seven.

Stauffer and Stauffer (1981), noting that a letter can be transformed by moving it and by changing its shape, suggest that children who consistently make reversal errors must not understand the rules that govern transformations of letters. They offer two instructional strategies in such situations: "First, if the child is verbally oriented, the rules and how they are to be applied can be explained to him. Secondly, and this is probably the more effective in the majority of cases, the ambiguities can be reduced." (p.137) Stauffer and Stauffer (1981) suggest the use of peg boards, felt or magnetic boards, etc., which allow the letters only to be attached in the correct orientation. They also stress that writing script may be easier than printing for children who reverse, since the strokes involved in writing make letters less ambiguous.

There are others who disagree with the notion of visual perceptual training (Hammill, 1972; Cohen, 1969; Allington, 1977; Cohn and Strickler, 1976; and Keislar, Hsieh, and Bhasin, 1972). Hammill (1972) stresses that correlational research does not support the contention that visual perceptual ability and first and second grade reading performance are highly related. Stressing that visual perception and reading comprehension are not highly related, Hammill (1972) feels that visual perceptual training programs cannot be expected to help reading ability, and therefore are of little value. Cohen (1969) agrees with this notion, stating that reading achievement will only be improved with work in reading, not perceptual training. Allington (1977) presented ninety 1st grade subjects with 120 high frequency words embedded in a match to sample

task. Ninety-six words fell below the 10% error rate, the mean number correct being 103.4. Reversals accounted for a very small percentage of the errors. The most prominent error occurred when the target word and a distractor differed in only one grapheme. Allington (1977) concluded that for those who consistently miscue on highly confusable words (i.e. went/want), it may be more helpful to direct attention to context cues, rather than stressing letter similarities and differences. Cohn and Strickler (1976) also caution against perceptual training programs, noting that the constancy principles taught in some of these programs might be counterproductive, causing errors when the child tries to identify lower case letters. They add: "The apparent success of these programs may well be based on naturally occurring maturational processes, plus the additional learning opportunities that time itself brings." (p.167)

Lahey and McNess (1975) through their work with preschool through third grade children did find that letter discrimination errors could be reduced through training. An appropriate caveat, though, is that this training focus on letter discrimination in particular, not perceptual processing in general.

Interactive theories of perception note that both the information in the head and the stimuli are involved in perceptual processing. Flavell (1977) states:

"...a good attentional system will look where it wants to, discriminate and identify only the wanted portion of what it sees, and give full attention (in perception, thought, or memory) only to the wanted portion of what it discriminates and identifies. There is much that we still do not know about how, where, and when these selection or filtering processes operate, and also just what does and what does not develop in these respects. But almost certainly an overall developmental trend exists toward greater voluntary control over one's perceptual-attentional processes." (p.169)

Relating this to the field of reading, it has been argued that there is no one particular cause of reading disability, the least of which being a

perceptual deficit (Vellutino, 1977; Vellutino et al., 1977; Vellutino and Scanlon, 1982; Vellutino, 1982; Allington, in press; Allington, 1982; Rawson, 1977; and Fischer, Liberman, and Shankweiler, 1978). The major tenet held here is that there are many cues available to the reader: graphic, orthographic, phonologic, semantic and systactic. Since three of these categories imply linguistic rather than perceptual processes, it would seem that reading relies more heavily on verbal ability. Moyer and Newcomer (1977) suggest that while the traditional view is that reversals indicate perceptual disorders, this should not be maintained without substantiating evidence. They state: "...the prevalent assumption is that reversals reflect impaired neurological processes or developmental deficits is erroneous, and...reversals often result from nothing more than a child's unfamiliarity with the concept of directionality as it related to letter discrimination." (p.424)

Vellutino (1977) stresses that if children who are said to have dyslexia actually perceived letters in a visual-spatial confused fashion, they would most likely exhibit this problem in other activities. Since there is no such evidence of this carry over, the perceptual-deficit hypothesis of reading dysfunction might be seriously questioned.

Lending support to Vellutino's (1977) contention are the results of a study conducted by Fischer, Liberman, and Shankweiler (1978). Subjects were boys aged 8 to 10 who were labeled either backward readers or dyslexics. Tasks involved the reading of word lists and identification of briefly exposed single letters. In both groups of subjects, vowel and other consonant errors comprised a much larger proportion of errors than did reversals. When reversals were made, there was a greater percentage of reversals of orientation than of sequence. These authors concluded: "The common error patterns, as we have seen, reflect difficulties in phonemic segmentation of words in the lexicon, in phonetic recoding, and in mastery of the orthography - difficulties, in short,

with the linguistic characteristics of words rather than with their properties as visual patterns." (pp.508-509) Also in agreement is Rawson's (1978) notion that a child can have language difficulty without necessarily having learning or perceptual disabilities.

Vellutino (1982) summarizes an interactive model of perception in relation to reading in the following statement:

"I would like to suggest that the ultimate resolution of the controversy surrounding the perceptual unit issue may well be occasioned by serious consideration of the possibility that the unit of perception in word recognition is relative rather than absolute and depends on three important factors: (1) the conditions under which a given word is encountered; (2) the structural characteristics of the word itself; and (3) the knowledge, experience, and skill of the reader." (p.43)

While space precludes the discussion of all studies pertinent to reversals which have been reviewed, some general findings will be presented. Those studies which have tried to correlate reversals with reading disability have found, in general, that the smallest percentage of errors are caused by reversals.

Taylor, Satz and Friel (1979) presented 40 dyslexic and 40 non-dyslexic disabled readers with word lists. It was found that less than 10% of all response errors for both groups contained orientation or sequence reversals, and that there was no significant difference between the performance of the two groups. Allington, Gormley, and Truex (1976) presented 24 third graders (12 good and 12 poor readers) with 20 high frequency low-discriminability words. The subjects completed the following tasks with these words: (1) Match to form, standard remaining visible; (2) Delayed Recall - word flashed for 1 second, then select and mark the word in an array of distractors; (3) Reproduce from Memory - word flashed for 1 second, then write the word; and (4) Read the words as they are flashed in isolation. Significant differences between the good and poor readers were found only on the fourth task, where poor

readers correctly read a mean of 14.42 words while the good readers correctly read a mean of 17.75 words. It was noted that reversals accounted for a total of .5% of the errors made on all four tasks. Black (1973), in testing 100 retarded readers and 100 normal readers, found that when chronological age, grade, and intelligence are controlled, the two groups do not significantly differ in number of letter reversals, word reversals, and Bender rotations. Kaufman (1976-1977) presented 15 non-retarded exceptional children (11 aged 7-0 to 8-9 yr. and 4 aged 13-6 to 15-10 yr.) with a battery of tests. The battery included: (1) Horst Reversal Test; (2) Test IV of the Frostig Developmental Test of Visual Perception; (3) the Wagner Oral Inventory for Reversals; (4) Chapman and Wendell Test for Reversal Errors; and (5) Slingerland Screening Test for Identifying Children with Specific Language Disability. Kaufman (1976-1977) found no correlation between the percentage of spatial orientation errors and reading grade, a result which leads one to question the general belief that children who are spatially disoriented will necessarily have poor reading ability.

Methodological Processes

Many studies designed to assess the tendency for reversals contain many methodological flaws, resulting in unpure tests of perceptual ability. Many studies combined perceptual ability with memory ability. Typically, these studies involved presenting a subject with a stimulus for a brief period, then, after the stimulus has been taken away, asking the subject to either reproduce the stimulus in writing or select it from an array of distractors. If the subject is asked to reproduce the stimulus in writing, you are concatenating perceptual ability not only with memorial processes, but also with motor ability. Another methodological flaw of reversal studies is the elicitation of verbal responses to the stimuli presented. For instance, in

a flash card type task, the subject is asked to name the symbol or word that is presented. If the stimulus is flashed then removed, as with a tachistoscope, and the subject is asked to name the stimulus, we again have a concatenation effect of perceptual ability, verbal ability, and memorial processes. With tasks such as those discussed, how can the investigator be sure that an error is due to a perceptual disability? I do not propose to have the one best answer to a "pure" test of perceptual ability, however, it would seem that the match to sample format where the stimulus and distractors remain visible and the subject is asked to point to the symbol or word in the array that matches the sample, would be considered optimal at this point.

An additional methodological problem is noted by both Cohn and Strickler (1979) and Tordrup (1966). They caution readers to pay close attention to the interpretations of such studies. They both suggested that the more proficient a child becomes in reading, the larger will be the proportion of the total errors accounted for by reversals, since the child is making fewer errors over all. Cohn and Strickler (1979), relating this to letter naming, state: "The more successful the group was in letter naming, the larger was the proportion of its errors that were reversals." (p.37) Tordrup (1966) makes the same contention with word identification: "...when it is a question of reading single words, the percentage of reversals is higher with higher proficiency in reading, no matter whether the children are normal or retarded readers." (p.180)

Relating the topic of reversals specifically to the field of reading, one finds a rather unique pattern in the literature. Of the 77 studies reviewed for this discourse, 6 studies, that is, less than 8%, measured reversal tendencies when reading connected text. Given the fact that so many researchers have tried to correlate the tendency to reverse with reading disability, this pattern was rather surprising. Since much of the reading a child is asked to do,

particularly from the end of first grade on, takes place in connected text, this would seem the more logical place to assess the tendency to reverse, especially if trying to correlate it with reading disability. The six studies assessing the tendency to reverse in connected text will be treated in chronological order, since they span 46 years of work.

Hildreth (1934) conducted a study with primary grade children (grades 2 to 4) in order to determine the tendency of these children to make reversals in reading and writing tasks. The reading tasks included a flash card presentation (exposure duration 3 sec.) of 50 words increasing in graded difficulty, and three oral reading paragraphs ranging in difficulty from the first to the fifth grade level. For the writing task, a card was flashed for a 3 second exposure, and after being taken away, the subjects had to write the word from the card. In addition to these types of assessment, the subjects were also given intelligence tests; those in the public schools were assessed by the Kuhlmann-Anderson Intelligence Test, and those in the private schools were given the Stanford-Binet. Children were also examined for handedness. It was found that in general, reversals in reading accounted for a very small percentage of the total number of errors made (ranging from .2% to 1% for the public school children and 1% for the private school children). Specifically in the paragraph reading, reversals accounted for between .3% and 1.9% of all errors made. It was noted that when confusion did occur, it was generally in the middle of a word, rather than in the initial or final positions. Hildreth (1934) states: "When children meet an unfamiliar word, they tend strongly to substitute for it a word of the same general length and configuration, containing at least some of the same letters, but a word that is meaningful to them." (p.9)

In the writing task, it was found that the number of reversals made was quite close to the number of omissions. Those items that were reversed were

either unfamiliar to the children or contained mirror images. It was found that only one child made reversals on all three tasks: the words in isolation, the oral reading paragraphs, and the writing task. Pertinent to the writing task, Hildreth (1934) concluded: "Single elements or parts cause more confusion than the elements as a whole, and difficulties seem often not so much inherent in the children as in the nature of the material." (p.15) Handedness was not found to be related to reversals, since left dominant and right dominant children made reversals similar in number and kind. Since there was no consistency between the tendency to reverse and poor reading ability, Hildreth concluded that the relationship between the two might be better characterized as associative rather than causal.

Madden and Pratt (1941) conducted an oral reading survey of 1154 subjects in grades 3 through 9. Subjects read orally a selection from a Social Studies text and a Science text at their appropriate grade level. Selections ranged in length from 100 to 225 words. At each grade level, the greatest proportion of errors were mispronunciations (50% or more). The smallest proportion of error type was that of reversals, ranging from 4% to 1%. The number of reversals made when reading connected text dropped drastically after third grade. Additions or omissions of articles were about double of what they were for other categories (i.e. verbs, nouns, pronouns, prepositions, and adverbs). The authors attributed this high occurrence of omissions and additions of articles to the fact that such errors can occur without greatly affecting the meaning or interpretation of the selection. Obviously, the findings of Madden and Pratt (1941) in reference to reversals in connected text are quite similar to Hildreth's (1934). While Hildreth's upper limit for reversals in connected text was .9% higher than Madden and Pratt's (1941) (1.9% versus 1%) it should be kept in mind that the latter study was assessing the tendency for reversals

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in older children.

Thomson (1978) analyzed the reading errors made in connected text by a group of dyslexic children and a normal group who were above average in reading ability. Analysis was performed by using Goodman's Taxonomy of Oral Miscues. The mean chronological age of all subjects was 10.5 years. The two groups exhibited no significant differences in numbers of the following types of errors: mispronunciations, substitutions, additions, reversals, syntactic acceptability, semantic acceptability and no response. The normal readers were found to make significantly more omissions, while the dyslexic readers made more errors at the level of graphic and phonemic similarity. Because of this, the dyslexic readers had a higher percentage of errors which were semantically unacceptable. Thus, the conclusion was drawn that dyslexics were guessing at words, paying less attention to meaning cues than to deciphering words. The dyslexic readers were found to be less accurate and slower in reading connected text, yet, for the purpose of this discourse, it must be stressed that they did not make significantly more reversals than the normal readers. This is also interesting from the standpoint that the tendency for reversals is claimed to be one of the indicators of dyslexia.

Collette (1979) noted that the classic pathognomic signs of dyslexia include the following: reversals and rotations in reading and spelling; insertions, substitutions and omissions of words and letters; poor handwriting; and inability to keep one's place on a page. Collette (1979) set out to investigate these types of errors with 144 subjects: 26 eighth and ninth grade dyslexics (aged 12-14), 19 non-dyslexic retarded readers (aged 12-14), and 96 average eighth and ninth grade students. Subjects were administered the Gray Oral Reading Test, the Wide Range Achievement Test (WRAT), and the Harris Test for Lateral Dominance. A handwriting sample was also taken. In the reading task, the dyslexic readers were found to make significantly more

reversal and substitution errors than did the retarded readers. The retarded readers were found to make significantly more spelling substitutions than did the dyslexics. In the writing task, both groups of disabled readers made more reversals, rotations, and errors in formation of loops than did the average readers. These results are not in agreement with those of Thomson's (1978) study previously discussed, yet similar conclusions were drawn. Collette (1979) concluded that the classic pathognomic signs of dyslexia are not reliable associated with those diagnosed as dyslexics, since both groups of disabled readers exhibited these types of errors. These signs are better associated with low reading achievement in general, rather than the specific problem dyslexia. Lower scores on these tests may reflect poor reading ability rather than neurological or perceptual impairment.

Schlieper (1980) tested the tendency of children in grades 1 through 3 to make reversal and sequence errors in meaningful text. A total of 237 subjects (71 at grade 1, 94 at grade 2, and 72 at grade 3) from three schools participated in the study. Subjects were administered the first four oral reading paragraphs of the Gates-McKillop Reading Test according to standard procedure. Three types of reversal errors were noted: letter reversals (i.e. b-d-p, n-u, w-m), word reversals (i.e. was-saw), and sequence errors which included any incorrect ordering of letters other than total reversals (i.e. felt-left). Error frequencies were tabulated for who groups (grade levels) and then for the ten best and the ten poorest readers at each grade level. When the whole group was considered, the first grade had the highest occurrence of all three types of reversal errors (letters: gr.1 - 4.5%, gr.2 - 2.1%, gr.3 - 1.0%; words: gr.1 - 3%, gr.2 - 2.4%, gr.3 - 2.2%; sequence: gr.1 - 2.2%, gr.2 - 1.0%, gr.3 - .9%). Considering these data, the smallest proportion of these three types of errors over the three grades was in the letter sequence category (1.8%). When the reversal and sequence

errors for the ten best and the ten poorest readers at each grade level were considered, a particularly interesting pattern presented itself at the first grade level. At this level, good readers made more errors than poor readers on letter reversals (2.5% vs. 2.3%) and letter sequence (7.5% vs. 1.9%), while on word reversals, the good readers had no errors and the poor readers had 2.1% of their errors fall into this category. At both the second and third grade levels, the ten best readers made no reversal or sequence errors, while the poorest readers did. At the second and third grade levels, the ten poorest readers made the most reversal errors on word reversals (3.6% and 2.6% respectively). Contrary to the first graders performance, the second and third grade best and poorest readers made the fewest number of errors in letter sequence. Schlieper (1980) concluded that there was "...no clear tendency for the poorest readers in any grade to exceed the total group in either number or proportion of errors." (p.76) What is evident in these results is that even among very young children, reversal and sequence errors account for a very small proportion of the total number of oral reading errors made. The author stresses that the cues available in meaningful text make the occurrence of reversal and sequence errors much less frequent than would occur with word lists or isolated stimuli. The context of the connected text can also constrain errors. The following data from Schlieper's (1980) study are offered as examples: of 25 opportunities for real words to be formed by right-left reversals, only six occurred, and two words accounted for 93% of all word reversal errors (in both cases, on-no and was-saw, the reversed word made sense with the preceeding context); 47% of the sequence errors provided meaningful substitutions; and only 19 elicited reversals and two words accounted for over half of all reversal errors at the letter level.

Krieger (1981) also found that reading errors were constrained by the context of connected text. In this study, 17 disabled readers from a

reading clinic (instructional level $\bar{X} = 2.8$, actual grade $\bar{X} = 4.2$) and 13 poor readers from 4th grade (instructional level $\bar{X} = 2.3$, actual grade $\bar{X} = 4.1$) served as subjects. Subjects from the clinic were first given 95 confusable high frequency words in isolation, then were asked to orally read a story in which 65 of these same words were embedded. The order of the tasks was reversed for the fourth grade poor readers. In isolation, 22 of the words were miscued more than 20% of the time. These same words were missed much less frequently in connected text. The two groups (clinic and school) did not differ significantly in performance on these tasks. In isolation, the substitutions that were made tended to rely on the visual features of the word, while in context, errors tended to be constrained by syntax and semantics. In this study, reversals accounted for less than 3% of the total number of errors made. While this percentage is higher than the results of some of the studies previously discussed, it should be kept in mind that all subjects in this study were disabled readers.

Conclusion

In summary, it has been demonstrated that reversals, whether they are in sequence or orientation, comprise a very small proportion of the total number of errors made even by poor readers. Young children tend to make more reversals, yet this tendency generally disappears with age. Top-down theorists feel that the reversal tendency of young children is due to unfamiliarity with the stimuli, and that maturation will alleviate the problem. Bottom-up theorists feel that perceptual training will correct the tendency to reverse, yet it has been demonstrated that this type of training is generally unsuccessful, particularly with children beyond the age of seven. Interactive theorists state that if reversals were a perceptual problem, persistent reversers would exhibit the same problem of incorrect perception in other

activities, a phenomenon which has not yet been documented. The tendency to reverse has been considered an indicator of dyslexia, yet studies with dyslexics and normal disabled readers have demonstrated that the two groups do not differ significantly in the number and type of reversal errors made. The methods for assessing reversals have been fraught with methodological flaws, concatenating perceptual ability with verbal ability, motor ability, and memorial processes. While a major part of the research on reversals has sought to establish the connection between the tendency to reverse and poor reading ability, only a few studies have assessed reversal tendencies in connected text. Such studies have demonstrated that the proportion of reversals in connected text is very small in comparison to the other types of errors made, and that connected text can in fact help the child in constraining the type and number of reversals he/she makes.

It appears that in spite of the vast amount of research in this area, we still do not have a replicable answer as to why a very small percentage of older children and adults exhibit the tendency to reverse. Because of this, it is apparent that many people are still of the opinion that reversals represent primarily a perceptual problem. Allington (1982), in a study in which 100 classroom teachers and 100 specialists (resource room, reading teachers, etc.) completed a true/false questionnaire, found that these teachers tended to align themselves with the visual perceptual deficit hypothesis. The results of this study which are particularly pertinent to this discourse include the following: 1) 40% felt that reading difficulty was most often caused by visual perceptual handicaps; 2) 33% felt that 8 out of 10 learning disabled students have severe perceptual deficiencies; 3) 52% said that reversals during reading indicated visual perceptual disturbances; 4) 63% were in favor of insuring the development of visual perceptual ability prior to the onset of reading instruction; and 5) 29% felt that mixed cerebral

dominance caused perceptual processing problems. Unfortunately, these opinions of specialists and teacher are virtually in complete disagreement with what research studies have demonstrated.

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